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(54) DEVICE FOR CREATING DATA FOR ANALYSIS

(57) [Problem]

An analysis data creation apparatus, which enables an analyst to easily acquire an analysis file used for a data analysis work from operation information data, is provided.

[Solution]

An analysis data creation apparatus, according to the present embodiment, includes: a data storage in which data relating to an operation status of a device provided in an operating train is stored as operation information data; a master manager configured to hold a data extraction table defining a data item to be extracted when an analyst extracts the data item required for analysis from the operation information data stored in the data storage and creates an analysis file; a file creator configured to create the analysis file by extracting the data item from the operation information data based on the data extraction table held in the master manager; and a creation file storage in which the analysis file created by the file creator is stored.

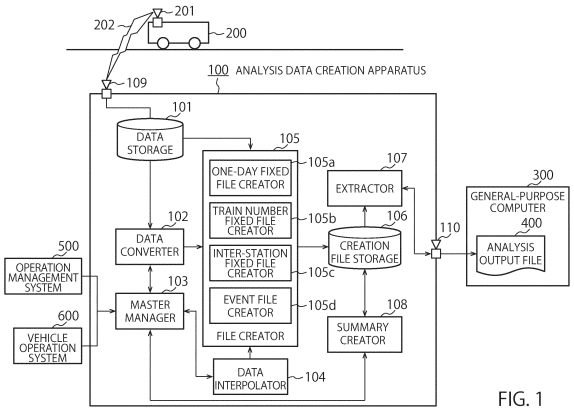

FIG. 1

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Description

Field

[0001] An embodiment of the present invention relates to an analysis data creation apparatus.

Background

[0002] By collecting and analyzing data on an operation status of a device provided in an operating train, an introduction of an apparatus that detects and predicts abnormalities in the device provided in the train is being promoted. In such apparatus, the manner of analyzing the collected data is important.

[0003] When analyzing data, (1) a data acquisition, (2) a data pre-processing, and (3) a data analysis is often performed in this order. With regard to (1) the data acquisition, a large amount of data can be acquired using various sensors provided in the device in the train. Here, the data sensed by the device in the train is referred to as an operation information data. In many cases, the sensed data is stored as it is, or data unnecessary for the analysis is included, and therefore a preparation work is required before data analysis. This is referred to as (2) the data pre-processing.

[0004] (2) The pre-processing of the data is often performed manually by an analyst using a local general-purpose computer having acquired the data. That is, the analyst acquires the operation information data by the local general-purpose computer, extracts a data item necessary for the data analysis, converts the data, and performs (3) the data analysis work. Among these tasks, the analyst wants to spend most of his time on (3) the data analysis, but in fact, he may also spend a lot of time on (1) the data acquisition and on (2) the data pre-processing.

Prior Art Documents

Patent Document

[0005]

Patent Document 1: Japanese Patent Application Laid-Open No. 2016 - 12240
Patent Document 2: Japanese Patent Application Laid-Open No. 2016 - 29516
Patent Document 3: Japanese Patent Application Laid-Open No. 2010 - 231708

Summary

Technical Problem

[0006] An analysis data creation apparatus, which enables an analyst to easily acquire an analysis file used for a data analysis work from operation information data, is provided.

Solution to Problem

[0007] An analysis data creation apparatus, according to the present embodiment, includes:

a data storage in which data relating to an operation status of a device provided in an operating train is stored as operation information data;
a master manager configured to hold a data extraction table defining data item to be extracted when an analyst extracts the data item required for analysis from the operation information data stored in the data storage and creates an analysis file;
a file creator configured to create the analysis file by extracting the data item from the operation information data based on the data extraction table held in the master manager; and
a creation file storage in which the analysis file created by the file creator is stored.

Brief Description of Drawings

[0008]

FIG. 1 is a block diagram explaining an entire configuration of an analysis data creation apparatus according to a first embodiment and the data exchanges with trains and peripheral devices.
FIG. 2 is a diagram showing an example of a configuration of operation information data stored in a data storage of the analysis data creation apparatus according to the first embodiment.
FIG. 3 illustrates an example of a conversion table for converting data regarding an operation status of a power running notch into a numerical value.
FIG. 4 illustrates an example of a conversion table for converting data regarding an operation status of a brake notch into a numerical value.
FIG. 5 is a diagram explaining contents of a data interpolation processing performed by a data interpolator of the analysis data creation apparatus according to the first embodiment.
FIG. 6 is a diagram showing an example of a data extraction table held by a master manager of the analysis data creation apparatus according to the first embodiment.
FIG. 7 is a diagram showing an example of a file storage configuration of a creation file storage of the analysis data creation apparatus according to the first embodiment.
FIG. 8 is a diagram for explaining an example of a data structure of a summary file created based on a one-day fixed file by a summary creator of the analysis data creation apparatus according to the first embodiment.
FIG. 9 is a diagram for explaining an example of a

data structure of a summary file created based on a train number fixed file by the summary creator of the analysis data creation apparatus according to the first embodiment.

FIG. 10 is a flowchart showing contents of a summary creation processing executed by the summary creator of the analysis data creation apparatus according to the first embodiment.

FIG. 11 is a diagram showing an example of a display screen displayed on a screen of a general-purpose computer connected to the analysis data creation apparatus according to the first embodiment.

FIG. 12 is a diagram showing an example of a display screen displayed on a screen of a general-purpose computer connected to an analysis data creation apparatus according to a second embodiment.

Description of Embodiments

[0009] Hereinafter, an analysis data creation apparatus according to several embodiments will be described with reference to the drawings. In the following description, components having substantially the same functions and configurations are denoted by the same reference numerals, and redundant descriptions will be made only when necessary.

[First Embodiment]

[0010] FIG. 1 is a block diagram explaining an entire configuration of an analysis data creation apparatus 100 according to a first embodiment and the data exchanges between the analysis data creation apparatus 100 and a train or peripheral devices.

[0011] As shown in FIG. 1, in the present embodiment, an electric railway vehicle 200 is assumed as an example of the train, and the analysis data creation apparatus 100 collects data relating to an operation status, such as a motor current value, from various devices provided on the electric railway vehicle 200. Here, the train exemplified by the electric railway vehicle 200 is composed of one or more vehicles, the number of vehicles constituting one train being arbitrary.

[0012] In this embodiment, the data relating to the operation status of the various devices provided on the electric railway vehicle 200 is transmitted to the analysis data creation apparatus 100 by a data transmitter 201 provided on the electric railway vehicle 200. For example, the data transmitter 201 transmits the data relating to the operation status of the devices to the analysis data creation apparatus 100 installed on the ground via a regular wireless line 202 while the train is running or stopped.

[0013] In this embodiment, the analysis data creation apparatus 100 includes a data storage 101, a data converter 102, a master manager 103, a data interpolator 104, a file creator 105, a creation file storage 106, an extractor 107, a summary creator 108, a data receiver 109, and a data transmitter/receiver 110.

[0014] The data relating to the operation status of the devices transmitted from the electric railway vehicle 200 is received by the data receiver 109. Then, the received data is subjected to a decompression processing and a conversion (such as plaintext processing) and stored in the data storage 101 as operation information data. The data may be stored in the data storage 101 at a predetermined cycle, or at an occurrence of an event such as a stop. That is, the data relating to the operation status of the devices generated on the electric railway vehicle 200 may be received every moment and stored in the data storage 101. When the data is stored in the data storage 101, the data relating to the operation status of the devices is compiled for each vehicle, that is, for each vehicle number. Since the data receiver 109 normally receives the data relating to the operation status of the devices from a plurality of vehicles of a plurality of trains, each of the data is stored in the data storage 101 by using vehicle numbers uniquely assigned to the vehicles as identification information.

[0015] FIG. 2 shows an example of the operation information data stored in the data storage 101. As shown in FIG. 2, the operation information data is compiled for each vehicle number. The data relating to the operation status of the devices is stored for each vehicle number together with the time when the data was generated. The vehicle number is an identifier of the vehicle and is not duplicated.

[0016] In the present embodiment, a table is prepared for each vehicle number, and the data relating to the operation status of the devices, which is acquired by the analysis data creation apparatus 100, is stored in chronological order starting from the top row of the table. Classifying the tables in accordance with vehicle numbers prevents the data of different vehicles from being compiled in the same table. The data relating to the operation status of the devices which is newly acquired by the analysis data creation apparatus 100 is sequentially added to the bottom of the rows in the table and stored.

[0017] The data storage 101 is constituted by a storage device such as a hard disk drive or a nonvolatile memory. If the data storage 101 has sufficient processing capacity, the analysis data creation apparatus 100 can also store the data received by the data receiver 109 as it is in the data storage 101, as the operation information data. The data items to be held as the operation information data are assumed to be, for example, a speed, a position, a motor current, a motor voltage, an operation amount, a normal/abnormal flag of the devices, and the like. These data are collected by the devices of the electric railway vehicle 200 in a cycle of one second or a cycle of 100 milliseconds, for example. Therefore, the data amount of the operation information data is enormous.

[0018] If the processing capacity of the data storage 101 is not sufficient, then all of the data relating to the operation status of the devices which are collected, for example, in a period of 100 milliseconds, may not be stored. The data may be thinned out to partially extract

data, for example, in a period of 10 seconds, and stored in the data storage 101 as the operation information data. Further, the data items stored and held in the data storage 101 may be limited to a part of the data items, thereby reducing the data amount of the operation information data.

[0019] As shown in FIG. 1 again, the data converter 102 converts the data included in the operation information data using a conversion table or a conversion formula. By this data conversion, it is possible to convert the data including character information and the like relating to the operation status of the devices into a numerical value which can be displayed in a graph. The numerical value after the data conversion may be additionally written in the operation information data stored in the data storage 101 by the data converter 102, or may be output from the data converter 102 to the file creator 105.

[0020] FIG. 3 is a diagram showing an example of a conversion table for converting the data relating to the operation status of the power running notch of the electric railway vehicle 200, and FIG. 4 is a diagram showing an example of a conversion table for converting the data relating to the operation status of the brake notch of the electric railway vehicle 200.

[0021] In FIG. 3, P1 is data indicating that the power running notch is operated in the state where the acceleration is the lowest, and P5 is data indicating that the power running notch is operated in the state where the acceleration is the highest. In the data conversion table of FIG. 3, P1 is converted into data having a numerical value of 1, and P5 is converted into data having a numerical value of 5.

[0022] In FIG. 4, B1 is data indicating that the brake notch is operated in the state where the braking is the lowest, and B5 is data indicating that the brake notch is operated in the state where the braking is the highest. In the data conversion table of FIG. 4, B1 is converted into data having a numerical value of 1, and B5 is converted into data having a numerical value of 5.

[0023] The power running notch and the brake notch of the electric railway vehicle 200 may be operated not only stepwise as shown in FIG. 3 and FIG. 4, but also continuously. In such a case, for example, a current value or a voltage value representing the magnitude of the power running notch or the brake notch may be obtained as data relating to the operation state, and the magnitude may be converted into data of numerical value representing a percentage by a conversion formula. The data converter 102 can also convert the data including the character information into the data of the numerical value by using a conversion formula instead of the conversion table.

[0024] As shown in FIG. 1 again, the master manager 103 manages the conversion table and/or the conversion formula used in the above-described data converter 102. In addition, information from an external system that is not stored in the data storage 101 is acquired and managed.

[0025] A typical example of the information from the external system is a timetable. Railways are usually managed by the train timetable. The timetable varies between weekdays, weekends, holidays, and so on. In order to make a graph based on the timetable, the time is often plotted on the horizontal axis and the station location on the vertical axis. Then, the graph is expressed by connecting points determined by the departure time and the departure station and points determined by the arrival time and the arrival station.

[0026] In the railway business, the timetable is often managed by another system called an operation management system 500. There are two types of timetable: the scheduled timetable which shows the scheduled departure time and arrival time, and the actual timetable which shows the actual departure time and arrival time. The delay can be evaluated by the difference between the departure time and arrival time of the scheduled timetable and the departure time and arrival time of the actual timetable.

[0027] Generally, a train number as an identifier is determined for a line connecting the starting station and the terminal station. In the operation of railways, it is decided which vehicles are allocated to each train number. This is called a vehicle allocation. The operation management of the vehicle is often managed by a vehicle operation system 600 different from the operation management system 500.

[0028] The operation management system 500 holds information about the timetable, and the vehicle operation system 600 holds information about the vehicle allocation in the timetable. The master manager 103 acquires and holds the information on the timetable and the information on the vehicle allocation, so that even if the train number, the vehicle number, or the like is missing from the operation information data stored in the data storage 101, it is possible to compensate for these.

[0029] The data interpolator 104 performs an interpolation of the missing data. Specifically, when the train number, the vehicle number, or the like is missing from the operation information data stored in the data storage 101, the data interpolator 104 searches the information on the timetable and the information on the vehicle allocation stored in the master manager 103, and adds the corresponding data to the operation information data.

[0030] FIG. 5 is a diagram explaining contents of a data interpolation processing performed by the data interpolator 104. As shown in FIG. 5, for example, when the train number information is missing from the operation information data stored in the data storage 101, the train number is interpolated by searching the information on the timetable and the information on the vehicle allocation stored in the master manager 103. For example, the data interpolator 104 searches the information on the vehicle allocation, searches for the train number to which the vehicle number A of the corresponding day is allocated, and as a result of the search, adds the specified train number to the operation information data.

[0031] As shown in FIG. 1 again, the file creator 105 creates an analysis file corresponding to a purpose of analysis for each vehicle number based on the operation information data stored in the data storage 101. In this embodiment, the file creator 105 includes a one-day fixed file creator 105a for creating an analysis file for one day of operation information data, a train number fixed file creator 105b for creating an analysis file for train numbers, an inter-station fixed file creator 105c for creating an analysis file for inter-station of the operation information data, and an event file creator 105d for creating an analysis file for a specific event such as a stop. Of course, the files created by the file creator 105 are not limited to these files, and various files may be created according to the purpose of the analysis.

[0032] Here, when the purpose of the analysis is, for example, to analyze running and energy or to analyze the surroundings of the motor, in many cases, the data items required for the analysis are not all items of the operation information data. Therefore, the file creator 105 selects the necessary data items for one day of train numbers, inter-station, and events, and extracts the data items necessary for the analysis from the operation information data. Here, in order to select the necessary data items, the file creator 105 uses the data extraction table stored in the master manager 103.

[0033] FIG. 6 is a diagram showing an example of the data extraction table held by the master manager 103 according to the present embodiment. As shown in FIG. 6, in the data extraction table according to the present embodiment, all data items that can be acquired from the operation information data stored in the data storage 101 are listed. In the example of FIG. 6, each column corresponds to each data item. In each row, the types of files for the analysis, such as the analysis data 1, the analysis data 2, and the analysis data 3, which are created according to use, are shown. "1" is stored in the data item to be extracted when the analysis file is created. On the other hand, "0" is stored in a data item which does not need to be extracted when the analysis file is created. That is, in the example of FIG. 6, "1" is stored as an information indicating that the data item is to be extracted, and "0" is stored as an information indicating that the data item is not to be extracted.

[0034] Referring to the row of the analysis data 1 as an example, "1" is stored for each of the data items 1 to 10, and therefore, it is shown that the data items 1 to 10 are data items to be extracted. In the analysis data 2, "1" is stored for each of the data items 1 to 5 and 8 to 10, and "0" is stored for each of the data items 6 and 7. Therefore, it is shown that the data of the data items 1 to 5 and the items 8 to 10 are extracted, but the data of the data item 6 and the data item 7 are not extracted. In the analysis data 3, "1" is stored for each of the data items 1 to 7, and "0" is stored for each of the data items 8 to 10. Therefore, it is shown that the data of the data items 1 to 7 are extracted, but the data of the data items 8 to 10 are not extracted.

[0035] For example, when the analysis data 1 corresponds to a one-day fixed file, the one-day fixed file creator 105a of the file creator 105 selects data to be extracted from the operation information data stored in the data storage 101 on the basis of an information relating to data extraction stored in the row of the analysis data 1 of the data extraction table. By using the data extraction table in this manner, it is possible to efficiently extract the data item necessary for creating the analysis file. In addition, even if the analyst desires to add a data item to the analysis file once he has looked at the analysis file and performed a detailed analysis, the data item can be added to the analysis file by simply changing the corresponding data item in the data extraction table from 0 to 1. On the other hand, even if the analyst desires to delete a data item from the analysis file after he has looked at the analysis file and performed a detailed analysis, the data item can be prevented from being included in the analysis file by simply changing the data item in the data extraction table from 1 to 0.

[0036] The timing when the file creator 105 creates the analysis file is arbitrary. For example, the one-day fixed file creator 105a may create the one-day fixed file by using the fact that all the operation information data of the day is stored in the data storage 101 as a trigger. The train number fixed file may be created by the train number fixed file creator 105b by using the fact that the train of the corresponding train number has ended its run and the operation information data including the end time has been stored in the data storage 101 as a trigger. The inter-station fixed file may be created by the inter-station fixed file creator 105c by using the fact that all the operation information data of the day is stored in the data storage 101 as a trigger. Regarding the event file, the event to be detected may be defined in the master manager 103, and the event file may be created by the event file creator 105d by using the occurrence of the event corresponding to the definition in the train as a trigger. For example, the event file creator 105d creates the event file by extracting the operation information data for a 30-second period before and after the event by using data including the vehicle number of the vehicle constituting the train in which the event occurred and including the time of occurrence. These analysis files created by the file creator 105 are stored in the creation file storage 106. Although the data format of the analysis file is arbitrary, in this embodiment, for example, the file is created in a CSV format.

[0037] Also, when the data extraction table held by the master manager 103 is updated, the file creator 105 may automatically recreate the analysis file based on the updated data extraction table. For example, when the analyst changes the value of some data items in the data extraction table from 0 to 1 by using a general-purpose computer 300, the file creator 105 may recreate the analysis file again based on the updated data extraction table.

[0038] Further, when at least one of the conversion table and the conversion formula held in the master man-

ager 103 is updated, the data converter 102 may automatically convert the operation information data stored in the data storage 101 to the numerical value based on the updated conversion table and the conversion formula. Thereafter, the file creator 105 may automatically create the analysis file based on the operation information data including the newly converted numerical value.

[0039] As shown in FIG. 1 again, the creation file storage 106 stores and holds the analysis file created by the file creator 105. FIG. 7 is a diagram showing an example of a file storage configuration of the creation file storage 106 according to the present embodiment. In the example of FIG. 7, a hierarchically lower-level folder is created with the vehicle number as its higher-level folder. In this case, a "one-day" lower-level folder, a "train number" lower-level folder, an "inter-station" lower-level folder, and an "event" lower-level folder are created.

[0040] The file name of the analysis file is named so that it can be distinguished from each other, and therefore, for example, the one-day fixed file is named so that the file name includes a date. The train number fixed file is named so that the file name includes the train number and the data start date or data end date of the train. In the inter-station fixed file, the train number fixed file for each train number is further divided for each station, and the file name is named so as to include information on the departure station and the arrival station. The event file is named so that the file name includes a unique ID for identifying the event and the date and time of occurrence.

[0041] The analysis file stored in the creation file storage 106 may be automatically deleted after a predetermined period of time has elapsed, for example, 1 years after the creation. The creation file storage 106 may automatically delete the analysis file by itself, or the file creator 105 may periodically search the creation date of the analysis file stored in the creation file storage 106, and delete the analysis file if it is detected after a predetermined period of time has elapsed. This makes it possible to reduce the storage occupancy of the creation file storage 106.

[0042] When a download request for the analysis file is received from the external general-purpose computer 300 connected via the data transmitter/receiver 110, the extractor 107 extracts the analysis file that matches the condition from the creation file storage 106 and transmits the extracted file as an analysis output file 400 to the general-purpose computer 300 which is the download request source. That is, since the analyst designates the analysis file required for analysis or designates the condition of a necessary file via the general-purpose computer 300, the extractor 107 acquires the analysis file matching the designated condition from the creation file storage 106 and transmits it to the general-purpose computer 300 as the analysis output file 400 via the data transmitter/receiver 110.

[0043] The summary creator 108 creates a summary file, which allows the analyst to grasp the outline of the analysis file, based on the analysis file stored in the creation file storage 106. Then, the summary creator 108 stores the created summary file in the creation file storage 106.

[0044] FIG. 8 is a diagram illustrating an example of the data structure of the summary file created by the summary creator 108 based on the one-day fixed file, and FIG. 9 is a diagram illustrating an example of the data structure of the summary file created by the summary creator 108 based on the train number fixed file. The summary files shown in FIG. 8 and FIG. 9 both show a summary of the operation. Here, the summary of the operation is a calculation of a statistic at the time of operation in units of each file.

[0045] In the example of FIG. 8, the travel distance, the maximum speed, and the consumed energy are statistics to be calculated for each vehicle number. The date on which the statistic was calculated is held as an additional information. In the example of FIG. 9, for each train number, the travel distance, the maximum speed, and the consumed energy are statistics to be calculated. Further, the train number and the start date of the train of the train number are held as an additional information. However, the items for which the summary creator 108 calculates the statistics are not limited to these items, and they can be arbitrarily set from the outside. For example, the analyst can operate the general-purpose computer 300 to specify a statistic to be calculated by the summary creator 108. The analysis file used to create the summary file is not limited to the one-day fixed file and the train number fixed file, and the summary file may be created using other analysis files.

[0046] The summary creator 108 may also calculate the number of pieces of data satisfying a predetermined abnormal condition as a statistic from the analysis file, and add the calculation result to the summary file. For example, a case where the maximum speed exceeds a predetermined value may be defined as an abnormal condition, and the number of corresponding pieces of data may be calculated as a statistic. The definition of the abnormal condition may be held by the summary creator 108 or may be held by the master manager 103 and acquired by the summary creator 108.

[0047] Further, the summary creator 108 may acquire an information about the scheduled timetable held in the master manager 103, compare the departure time and arrival time of the scheduled timetable with the actual departure time and arrival time of the operation, calculate the delay time as a statistic, and add it to the summary file. The actual departure time and arrival time of the operation may be obtained from the analysis file stored in the creation file storage 106, from the operation information data stored in the data storage 101, or from the actual timetable held by the master manager 103.

[0048] When one analysis file is created, the summary creator 108 calculates a statistic based on the data stored in the analysis file and adds the calculation result on the bottom line of the summary file. Therefore, the summary

creator 108 performs a process of reading out the existing summary file from the creation file storage 106, adding the calculation result thereto, and storing it again in the creation file storage 106. If the statistic can be calculated by the summary creator 108 based on a data item that can be calculated even before the completion of the creation of the one analysis files, the summary creator 108 may read the analysis file and create the summary file at the timing when the statistic can be calculated for the data item.

[0049] FIG. 10 is a flowchart showing the contents of the summary creation processing executed by the summary creator 108 according to the present embodiment. As shown in FIG. 10, the summary creator 108 determines whether or not a timing for creating a summary file has been detected (step S10). As described above, the timing at which the summary file is created includes the timing at which the analysis file is created, the timing at which the statistic can be calculated, and so on. If the timing for creating the summary file is not detected (step S10: No), the summary creation processing is terminated.

[0050] On the other hand, when the timing for creating the summary file is detected (step S10: Yes), the summary creator 108 acquires an analysis file necessary for calculating a statistic, from the creation file storage 106 (step S12). Then, the data item necessary for calculating the statistic is read out from the analysis file, and the required statistic is calculated (step S14).

[0051] Next, the summary creator 108 acquires, from the creation file storage 106, the existing summary file in which previously created statistics are stored (step S16). Subsequently, the summary creator 108 adds the calculation result of the statistic in step S14 to the existing summary file and stores this new summary file in the creation file storage 106 (step S18). Then, the summary creation processing is ended.

[0052] The summary file stored in the creation file storage 106 can be obtained by the general-purpose computer 300 as the analysis output file 400 by designation by the analyst who operates the general-purpose computer 300. That is, when a condition is specified from the general-purpose computer 300, the extractor 107 extracts a summary file that matches the specified condition from the creation file storage 106 and outputs it to the general-purpose computer 300 as the analysis output file 400.

[0053] FIG. 11 is a diagram showing an example of a display screen W1 displayed on a screen provided to the general-purpose computer 300. In this embodiment, the display screen W1 is displayed by the Web browser of the general-purpose computer 300. The drawing control for displaying the display screen W1 on the Web browser of the general-purpose computer 300 is executed by the extractor 107 of the analysis data creation apparatus 100.

[0054] As shown in FIG. 11, four tabs, namely, an event tab TB1, a one-day fixed tab TB2, a train number fixed tab TB3, and an inter-station fixed tab TB4, are displayed on the display screen W1. The analyst selects one of the tabs as the data he wants to analyze, considering which analysis file is the most suitable.

[0055] The display screen W1 includes a train number designation field FD1, a vehicle number designation field FD2, a start time designation field FD3, an end time designation field FD4, a template download type designation field FD5, and a destination mail address designation field FD6. These specified fields can also be changed when one of the four tabs is selected.

[0056] The train number designation field FD1 is a field for inputting a train number which the analyst wishes to acquire for analysis. The vehicle number designation field TD2 is a field for inputting a vehicle number which the analyst wishes to acquire for analysis. The start time designation field FD3 is a field for inputting a start time of the operation information data which the analyst wishes to acquire for analysis. The end time designation field FD4 is a field for inputting an end time of the operation information data which the analyst wishes to acquire for analysis. The template download type designation field FD5 is a field for designating a type of the template to be downloaded by the analyst. The destination mail address designation field FD6 is a field for designating a destination address in the case of transmitting the downloaded analysis file by e-mail.

[0057] The analyst inputs a condition for obtaining optimum data for the analysis on the display screen W1 and acquires a target analysis file. That is, based on the input of the display screen W1, the general-purpose computer 300 transmits a download request for extracting at least one of the vehicle number of the vehicles constituting the train, the train number of the train, the start time of the operation information data, and the end time of the operation information data, to the extractor 107 of the analysis data creation apparatus 100. In response to the download request, the extractor 107 retrieves and extracts the analysis file matching the condition from the creation file storage 106 and transmits the file to the general-purpose computer 300 as the request source.

[0058] As described above, in the analysis data creation apparatus 100 according to the present embodiment, the analyst can connect the general-purpose computer 300 to the data transmitter/receiver 110 of the analysis data creation apparatus 100 and easily obtain the analysis output file 400 required for analysis. That is, the file creator 105 has created the analysis file organized to include predetermined data items such as the one-day fixed file, the train number fixed file, the inter-station fixed file, and the event file, and has stored the created file in the creation file storage 106, and therefore the analyst can easily acquire the necessary analysis file in a short time. Therefore, the analyst does not have to extract the necessary data items from the enormous amount of the operation information data and to create the analysis file each time. Therefore, the very short time of downloading from the creation file storage 106 the analysis file that has already been created is the time required for (2) the

data pre-processing.

[0059] Since the summary creator 108 has created the summary file and stored the summary file in the creation file storage 106, the analyst can grasp the outline of the data stored in the analysis file before performing detailed data analysis in the analysis file by acquiring the summary file as the analysis output file 400 in the general-purpose computer 300.

[0060] In this manner, the analyst can analyze the operation information data based on the analysis file stored in the creation file storage 106 from which the necessary data items have been extracted in advance, instead of directly acquiring the operation information data stored in the data storage 101 and extracting or arranging the data items necessary for the analysis. Therefore, it is possible to greatly shorten the work time such as (1) the data acquisition and (2) the data pre-processing, which has conventionally been very time consuming.

[0061] Regarding the operation information data of trains such as the electric railway vehicle 200, even if the data is separated by a predetermined time such as 10 minutes or 1 hour, there is a possibility that the data is not separated into meaningful data because the train is not in operation or is moving between stations. However, as in the present embodiment, by separating the operation information data by one-day, train numbers, inter-station, events, and the like, the data becomes meaningful data which is easy for the analyst to analyze. The analysis file created with this meaningful data is created in advance and stored in the creation file storage 106, and the analyst uses this analysis file, so that the time conventionally required for (2) data pre-processing for the analyst can be greatly reduced.

[Second Embodiment]

[0062] In the first embodiment described above, the analyst work regarding (1) the data acquisition and (2) the data pre-processing of the analyst can be reduced, but when a large amount of data is to be analyzed, the analyst must download and acquire a large number of the analysis files from the creation file storage 106. In this case, the time required to create the analysis files can be reduced but the time required to download the analysis files is expected to be considerably long.

[0063] On the other hand, the operation information data of the train is collected under various conditions. For example, when the analysis of the operation information data is in units of train numbers, the operation information data includes a mixture of data in which a large delay occurs and data in which no delay occurs. For example, when the energy consumption is evaluated, if a delay occurs, the energy consumption tends to be larger than that in a case where no delay occurs, because the operation information data that has been operated at a speed faster than that of the normal timetable in order to recover the delay is included. It may not make much sense to compare the operation information data under very different conditions.

[0064] Therefore, in the second embodiment, the contents of the summary files created by the summary creator 108 of the analysis data creation apparatus 100 according to the first embodiment and stored in the creation file storage 106, are visually depicted on the general-purpose computer 300 by using a Web browser, so that the analyst can efficiently select the analysis file. That is, the extractor 107 of the analysis data creation apparatus 100 provides the analyst with the Web browser for requesting a download and specifying an extraction condition.

[0065] FIG. 12 is a diagram showing an example of the display screen W2 displayed on the screen of the general-purpose computer 300 connected to the analysis data creation apparatus 100 according to the present embodiment. In the display screen W2 shown in FIG. 12, the statistic of the summary file related to the one-day fixed file is shown. Here, since the summary file of the one-day fixed file is displayed, the statistic of the vehicles having three different vehicle numbers is displayed. However, when the train number fixed file is displayed, the statistic of the different train numbers may be displayed, whereas when the inter-station fixed file is displayed, the statistic of the different inter-station may be displayed.

[0066] In the example of FIG. 12, the summary data items 1 and 2 in the summary file relating to the one-day fixed file are displayed in the form of a scatter diagram on a horizontal axis and a vertical axis, respectively. For example, the horizontal axis represents the travel distance in the summary file of FIG. 8, and the vertical axis represents the maximum speed in the summary file of FIG. 8. The triangle, circle, and square represent 1 one-day fixed file for each vehicle number.

[0067] The display format is not limited to the scatter diagram, and other display formats, such as histograms, may be used. The summary data items on the vertical axis or the horizontal axis are arbitrary, and may be data items held by the summary file, such as the travel distance, the maximum speed, and the consumed energy, or may be a statistic that can be calculated anew from the data items held by the summary file. In addition, the vertical axis or the horizontal axis may represent a statistic that can be calculated from timetable information managed by the operation management system 500 or vehicle allocation information managed by the vehicle operation system 600. The analyst can arbitrarily set what data items to be set on the vertical axis and the horizontal axis.

[0068] After the display screen W2 is displayed, the analyst selects the analysis file to be downloaded. In the present embodiment, the analyst operates a pointing device to move a pointer P1 on the display screen W2 and surrounds the analysis file to be downloaded with the frame box BX1. In this state, by clicking a download button B1, the selected analysis files, that is, the one-day fixed files are downloaded to the general-purpose computer 300. In the example of FIG. 12, 11 one-day fixed

files are downloaded.

[0069] As described above, in the analysis data creation apparatus 100 according to the present embodiment, the analyst can visually recognize the data such as the statistic of the summary file on the display screen W2 displayed on the general-purpose computer 300, and can easily grasp the contents of the summary file. In addition, it is possible to easily designate the necessary analysis file based on the visualized statistic of the summary file, and even to avoid downloading the analysis files not used for analysis. Thus, the download time can be shortened and the efficiency of the analysis work can be improved by omitting unnecessary data.

[0070] Although several embodiments have been described above, these embodiments are presented by way of example only and are not intended to limit the scope of the invention. The novel apparatus and methods described herein may be implemented in a variety of other forms. Various omissions, substitutions and modifications may also be made to the forms of the apparatus and methods described herein without departing from the spirit of the invention. The appended claims and their equivalents are intended to include forms and modifications such as those being contained in the scope and spirit of the invention.

Claims

1. An analysis data creation apparatus, comprising:

a data storage in which data relating to an operation status of a device provided in an operating train is stored as operation information data;
a master manager configured to hold a data extraction table defining data item to be extracted when an analyst extracts the data item required for analysis from the operation information data stored in the data storage and creates an analysis file;
a file creator configured to create the analysis file by extracting the data item from the operation information data based on the data extraction table held in the master manager; and
a creation file storage in which the analysis file created by the file creator is stored.

2. The analysis data creation apparatus according to claim 1, further comprising an extractor configured to extract the analysis file matching a condition from the creation file storage based on a received download request and transmit the extracted analysis file to a source of the download request.

3. The analysis data creation apparatus according to claim 2, wherein at least one of a vehicle number of a vehicle constituting the train, a train number of the train, a start time of the operation information data, and an end time of the operation information data are designated in the download request as the condition.

4. The analysis data creation apparatus according to claim 2, wherein the extractor provides a Web browser in which the analyst makes the download request and designates the condition for extracting the analysis file.

5. The analysis data creation apparatus according to claim 1, further comprising a data converter configured to convert the operation information data stored in the data storage into a numerical value.

6. The analysis data creation apparatus according to claim 5, wherein a conversion table and/or a conversion formula used when the data converter converts the operation information data into the numerical value is managed by the master manager.

7. The analysis data creation apparatus according to claim 6, wherein, when at least one of the conversion table and the conversion formula is updated, the data converter converts the operation information data stored in the data storage into the numerical value based on the updated conversion table and/or the updated conversion formula.

8. The analysis data creation apparatus according to claim 1, further comprising a data interpolator configured to perform an interpolation when there is a missing data item in the operation information data stored in the data storage.

9. The analysis data creation apparatus according to claim 8, wherein the data interpolator performs the interpolation of the missing data item based on an information on a timetable and an information on a vehicle allocation held in the master manager.

10. The analysis data creation apparatus according to any one of claims 1 to 9, further comprising a summary creator configured to create a summary file based on the analysis file stored in the creation file storage, wherein the summary file provides the analyst with an outline of the analysis file.

11. The analysis data creation apparatus according to claim 10, wherein the summary creator calculates a statistic based on data stored in the analysis file and creates the summary file based on a result of the calculated statistic.

12. The analysis data creation apparatus according to claim 11, wherein the statistic calculated by the summary creator can be set from outside.

13. The analysis data creation apparatus according to claim 11, wherein the summary creator calculates a number of pieces of data satisfying a predetermined abnormal condition as the statistic.

14. The analysis data creation apparatus according to claim 11, wherein the summary creator compares a departure time and an arrival time of a scheduled timetable with a departure time and an arrival time of an actual operation and calculates a delay time as the statistic.

15. The analysis data creation apparatus according to claim 1, wherein, when the data extraction table held by the master manager is updated, the file creator creates the analysis file based on the updated data extraction table again.

16. The analysis data creation apparatus according to claim 1, wherein the analysis file stored in the creation file storage is deleted after a predetermined period of time has elapsed.

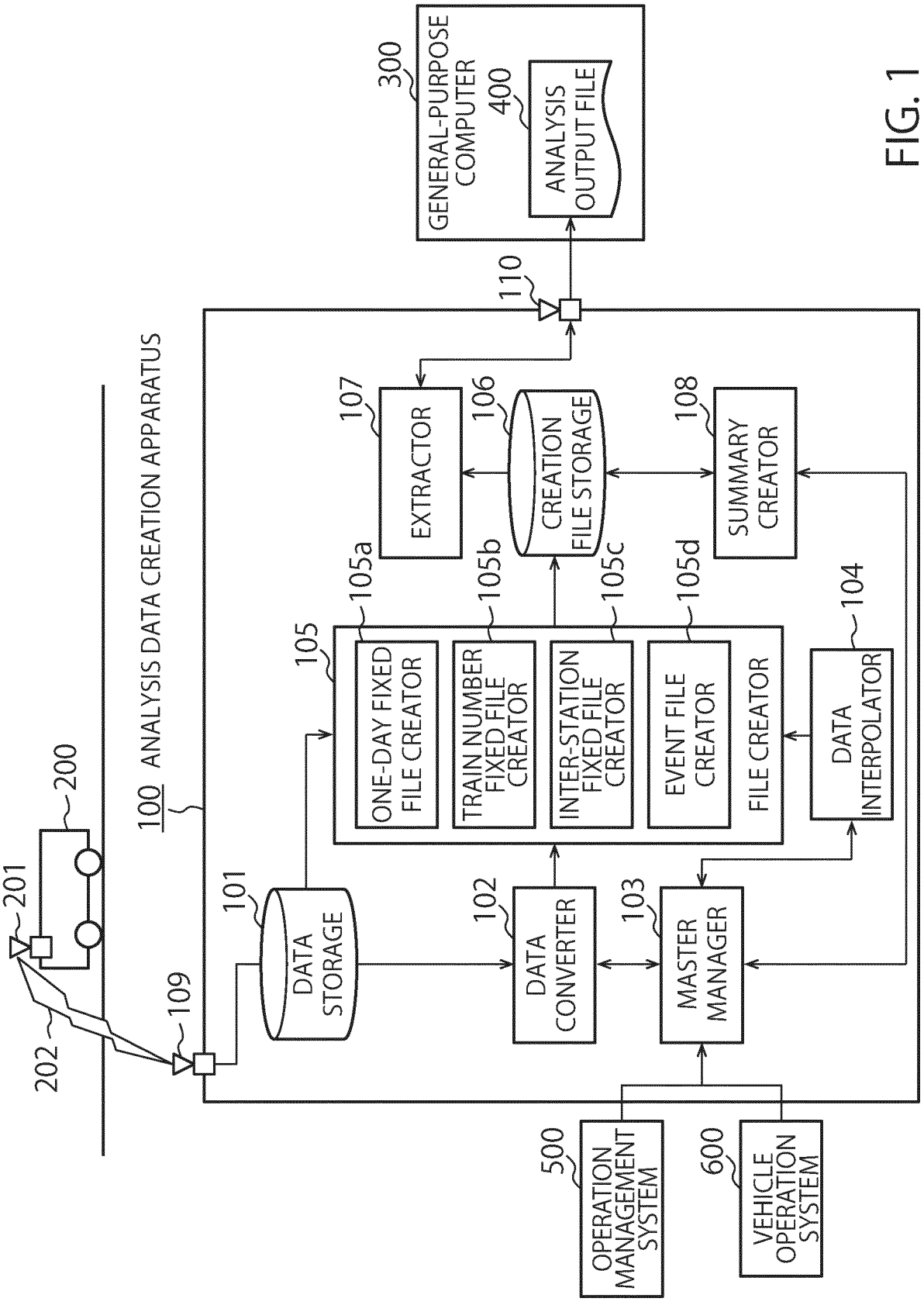

300
GENERAL-PURPOSE COMPUTER
400
ANALYSIS OUTPUT FILE
110
100 ANALYSIS DATA CREATION APPARATUS
107
EXTRACTOR
106
CREATION FILE STORAGE
108
SUMMARY CREATOR
105a
105b
105c
105d
105
ONE-DAY FIXED FILE CREATOR
TRAIN NUMBER FIXED FILE CREATOR
INTER-STATION FIXED FILE CREATOR
EVENT FILE CREATOR
FILE CREATOR
104
DATA INTERPOLATOR
200
201
202
109
101
DATA STORAGE
102
DATA CONVERTER
103
MASTER MANAGER
500
OPERATION MANAGEMENT SYSTEM
600
VEHICLE OPERATION SYSTEM

FIG. 1

VEHICLE NUMBER A

TIME	POSITION	SPEED	ELECTRIC POWER	・・・
2/3 10:01:01	x1	va1	wa1	
2/3 10:01:02	x2	va2	wa2	
2/3 10:01:03	x3	va3	wa3	
2/3 10:01:04	x4	va4	wa4	
2/3 10:01:05	x5	va5	wa5	
2/3 10:01:06	x6	va6	wa6	
2/3 10:01:07	x7	va7	wa7	

VEHICLE NUMBER B

TIME	POSITION	SPEED	ELECTRIC POWER	・・・
8/5 14:13:12	x1	vb1	wb1	
8/5 14:13:13	x2	vb2	wb2	
8/5 14:13:14	x3	vb3	wb3	
8/5 14:13:15	x4	vb4	wb4	
8/5 14:13:16	x5	vb5	wb5	
8/5 14:13:17	x6	vb6	wb6	
8/5 14:13:18	x7	vb7	wb7	

FIG. 2

DATA CONVERSION TABLE

DATA INDICATION	CONVERTED VALUE
P1	1
P2	2
P3	3
P4	4
P5	5

FIG. 3

DATA CONVERSION TABLE

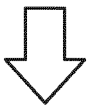
DATA INDICATION	CONVERTED VALUE
B1	1
B2	2
B3	3
B4	4
B5	5

FIG. 4

OPERATION INFORMATION DATA

VEHICLE NUMBER A

TIME • • •	POSITION	SPEED	ELECTRIC POWER	TRAIN NUMBER
2/3 10:01:01	x1	va1	wa1	
2/3 10:01:02	x2	va2	wa2	
2/3 10:01:03	x3	va3	wa3	
2/3 10:01:04	x4	va4	wa4	
2/3 10:01:05	x5	va5	wa5	
2/3 10:01:06	x6	va6	wa6	
2/3 10:01:07	x7	va7	wa7	



OPERATION INFORMATION DATA

VEHICLE NUMBER A

TIME • • •	POSITION	SPEED	ELECTRIC POWER	TRAIN NUMBER
2/3 10:01:01	x1	va1	wa1	0001
2/3 10:01:02	x2	va2	wa2	0001
2/3 10:01:03	x3	va3	wa3	0001
2/3 10:01:04	x4	va4	wa4	0001
2/3 10:01:05	x5	va5	wa5	0001
2/3 10:01:06	x6	va6	wa6	0001
2/3 10:01:07	x7	va7	wa7	0001

FIG. 5

DATA EXTRACTION TABLE

	DATA ITEM 1	DATA ITEM 2	DATA ITEM 3	DATA ITEM 4	DATA ITEM 5	DATA ITEM 6	DATA ITEM 7	DATA ITEM 8	DATA ITEM 9	DATA ITEM 10
ANALYSIS DATA 1	1	1	1	1	1	1	1	1	1	1
ANALYSIS DATA 2	1	1	1	1	1	0	0	1	1	1
ANALYSIS DATA 3	1	1	1	1	1	1	1	0	0	0

FIG. 6

EP 3 805 070 A1

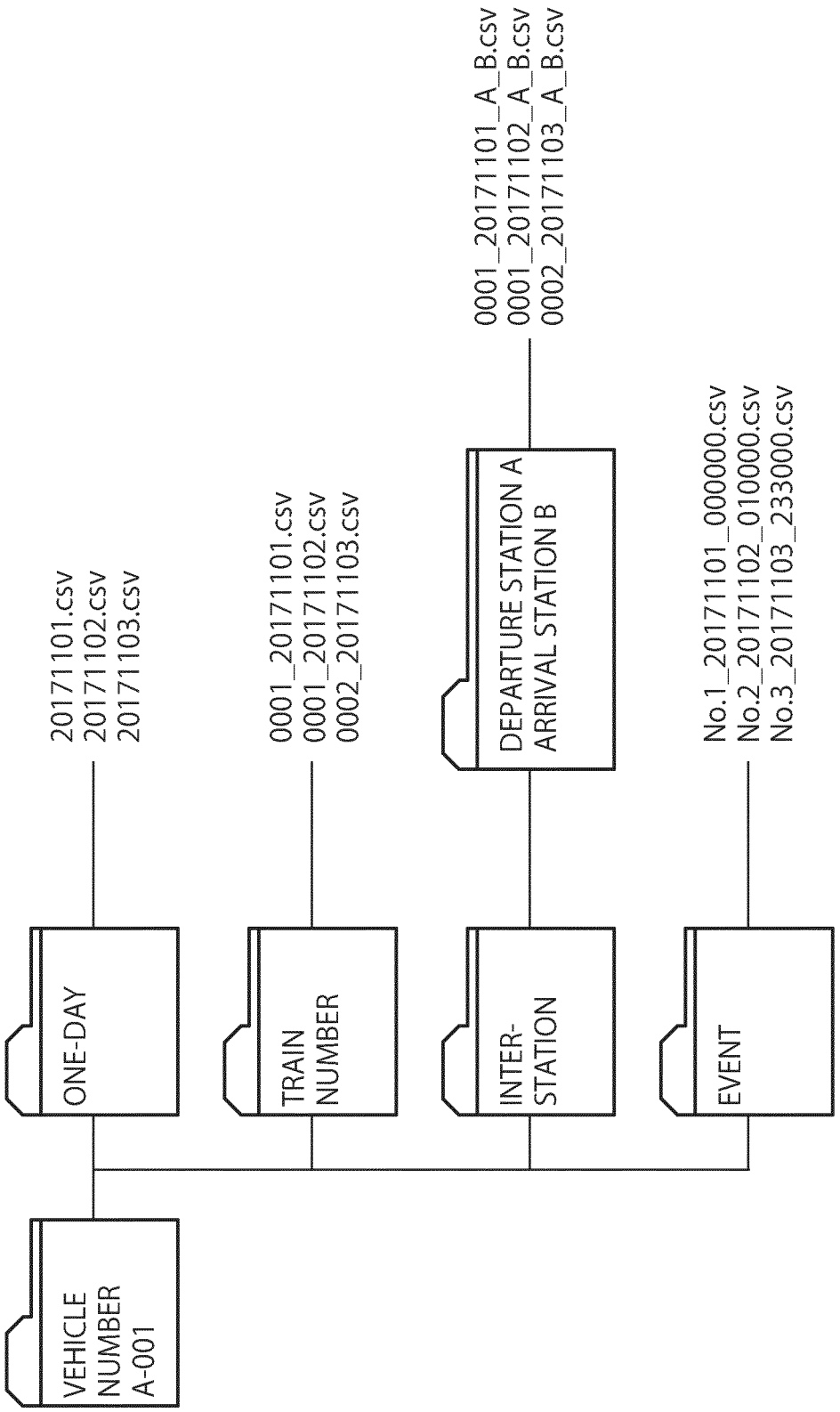

VEHICLE NUMBER A-001
ONE-DAY
20171101.csv
20171102.csv
20171103.csv
TRAIN NUMBER
0001_20171101.csv
0001_20171102.csv
0002_20171103.csv
INTER-STATION
DEPARTURE STATION A
ARRIVAL STATION B
0001_20171101_A_B.csv
0001_20171102_A_B.csv
0002_20171103_A_B.csv
EVENT
No.1_20171101_000000.csv
No.2_20171102_010000.csv
No.3_20171103_233000.csv

FIG. 7

VEHICLE NUMBER	DATE	TRAVEL DISTANCE [km]	MAXIMUM SPEED [km/h]	CONSUMED ENERGY [kWh]
A-0001	2017/11/01	100	100	100
A-0001	2017/11/02	100	90	90
A-0001	2017/11/03	200	95	190

FIG. 8

VEHICLE NUMBER	TRAIN NUMBER	START DATE OF TRAIN OF TRAIN NUMBER	TRAVEL DISTANCE [km]	MAXIMUM SPEED [km/h]	CONSUMED ENERGY [kWh]
A-0001	1001	2017/11/01	65	110	102
A-0001	1001	2017/11/02	65	93	91
A-0001	1003	2017/11/03	66	95	78

FIG. 9

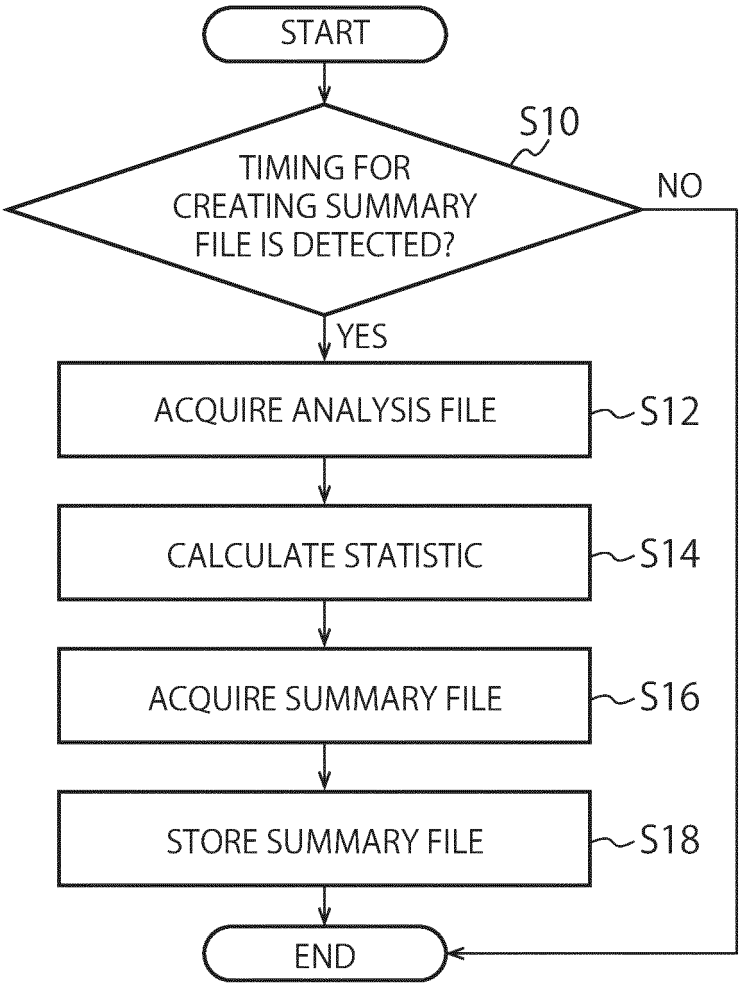

START
S10
TIMING FOR CREATING SUMMARY FILE IS DETECTED?
NO
YES
ACQUIRE ANALYSIS FILE
S12
CALCULATE STATISTIC
S14
ACQUIRE SUMMARY FILE
S16
STORE SUMMARY FILE
S18
END

FIG. 10

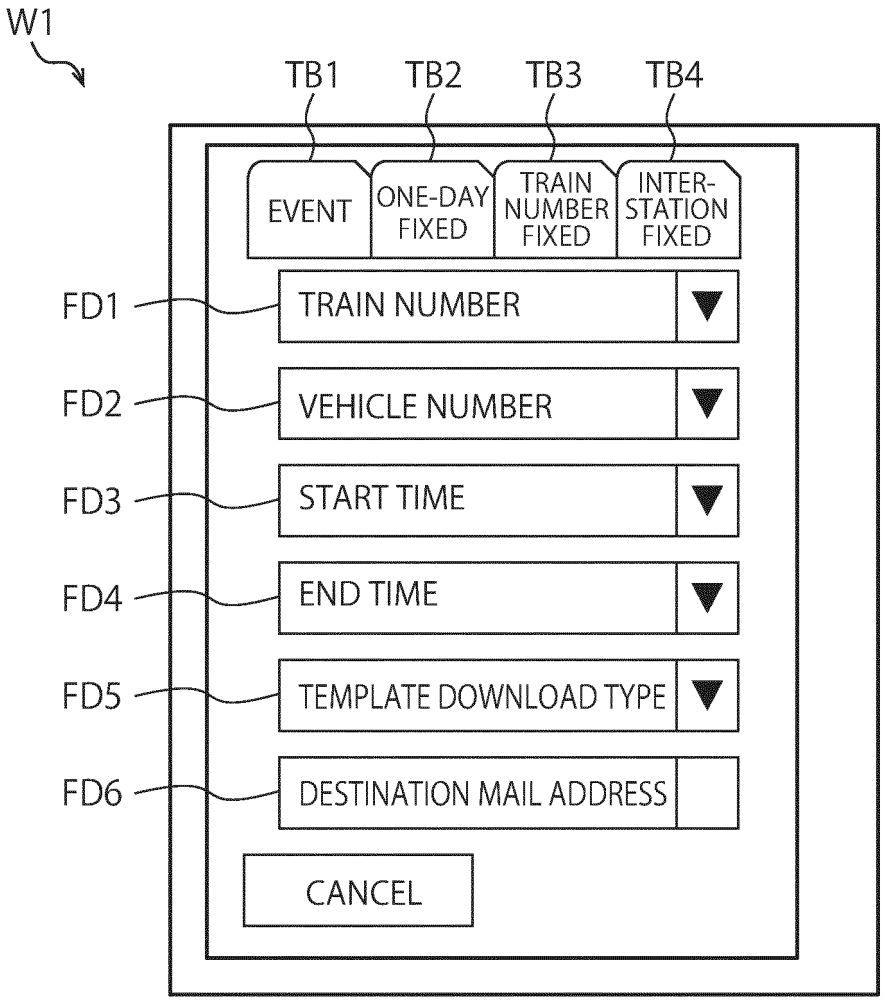

W1
TB1
TB2
TB3
TB4
EVENT
ONE-DAY FIXED
TRAIN NUMBER FIXED
INTER-STATION FIXED
FD1
TRAIN NUMBER
FD2
VEHICLE NUMBER
FD3
START TIME
FD4
END TIME
FD5
TEMPLATE DOWNLOAD TYPE
FD6
DESTINATION MAIL ADDRESS
CANCEL

FIG. 11

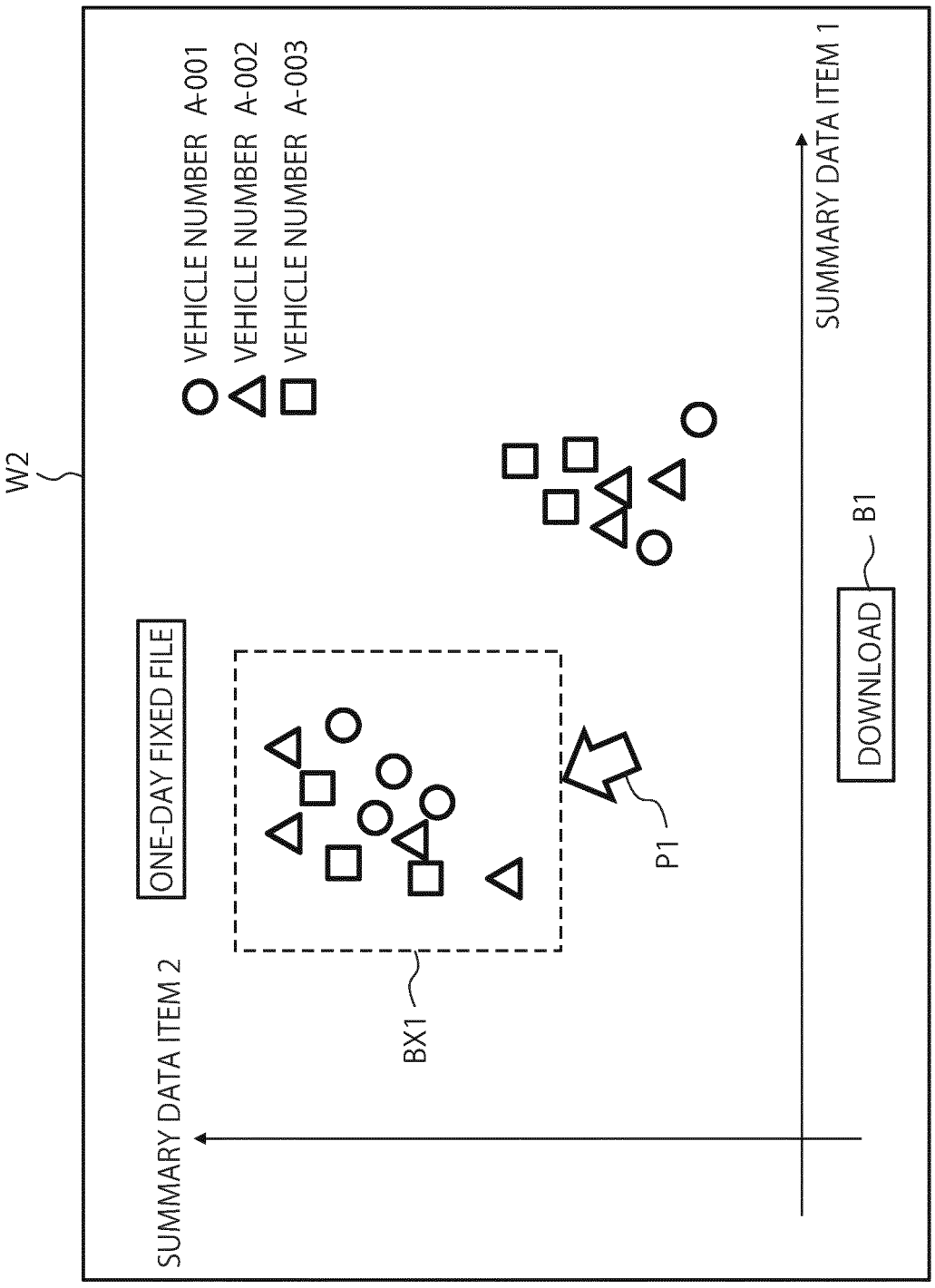

W2
VEHICLE NUMBER A-001
VEHICLE NUMBER A-002
VEHICLE NUMBER A-003
SUMMARY DATA ITEM 1
SUMMARY DATA ITEM 2
ONE-DAY FIXED FILE
BX1
P1
DOWNLOAD
B1

FIG. 12

INTERNATIONAL SEARCH REPORT

International application No.
PCT/JP2019/015259

A. CLASSIFICATION OF SUBJECT MATTER
Int. Cl. B61L25/04(2006.01)i, B61L27/00(2006.01)i

According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)
Int. Cl. B61L25/04, B61L27/00

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched
Published examined utility model applications of Japan 1922-1996
Published unexamined utility model applications of Japan 1971-2019
Registered utility model specifications of Japan 1996-2019
Published registered utility model applications of Japan 1994-2019

Electronic data base consulted during the international search (name of data base and, where practicable, search terms used)

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X Y A	JP 2017-109650 A (TOSHIBA CORP.) 22 June 2017, paragraphs [0010]-[0096], fig. 1-15 & US 2017/0178426 A1, paragraphs [0026]-[0113]	1-7 8, 10-13, 15-16 9, 14
Y	JP 2014-169936 A (RAILWAY TECHNICAL RESEARCH INSTITUTE) 18 September 2014, paragraph [0041] (Family: none)	8, 10-13, 15-16

☐ Further documents are listed in the continuation of Box C. ☐ See patent family annex.

* Special categories of cited documents:
"A" document defining the general state of the art which is not considered to be of particular relevance
"E" earlier application or patent but published on or after the international filing date
"L" document which may throw doubts on priority claim(s) or which is cited to establish the publication date of another citation or other special reason (as specified)
"O" document referring to an oral disclosure, use, exhibition or other means
"P" document published prior to the international filing date but later than the priority date claimed
"T" later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention
"X" document of particular relevance; the claimed invention cannot be considered novel or cannot be considered to involve an inventive step when the document is taken alone
"Y" document of particular relevance; the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art
"&" document member of the same patent family

Date of the actual completion of the international search	Date of mailing of the international search report
11.06.2019	18.06.2019

Name and mailing address of the ISA/	Authorized officer
Japan Patent Office 3-4-3, Kasumigaseki, Chiyoda-ku, Tokyo 100-8915, Japan	Telephone No.

Form PCT/ISA/210 (second sheet) (January 2015)

REFERENCES CITED IN THE DESCRIPTION

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Patent documents cited in the description

- JP 2016012240 A **[0005]**
- JP 2016029516 A **[0005]**
- JP 2010231708 A **[0005]**